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Global changes, livestock and vulnerability: the social construction of markets as an adaptive strategy

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Nowadays, livestock producers in Sahel have to deal not only with climate variability but also with changes in land use and policies that restrict access to pasture and increase their vulnerability. At the same time, the growth of urban livestock markets both nationwide and in neighbouring countries is creating opportunities for producers. However, few studies have examined the role of markets in the adaptive strategies of livestock producers in West Africa, the changes in strategies for capturing market opportunities and the social interactions that lead to changes in market access and functioning. This paper addresses the question of how livestock producers and traders have transformed their producing and marketing strategies in response to climate variability and land access constraints. Our proposed conceptual framework on markets, vulnerability and adaptation considers that adaptive strategies include the social construction of markets through which market access is based on social networks and follows the norms and rules embedded in the complexity of these networks. This proactive strategy of stakeholders, through a socially constructed market access, allows traders to harness opportunities and livestock producers to adapt to climatic and land access constraints. We apply the framework in a case study in the region of Niono and Ségou in the Niger Inner delta in Mali. Results show that livestock producers and traders have changed their livestock-raising and marketing strategies in response to the challenges faced by livestock producers and the emerging market opportunities. This study highlights the importance of considering the social construction of livestock market systems and marketing behaviours as adaptive strategies of livestock producers to multiple changes. Although livestock markets can support the adaptive strategies of several types of producers, their functioning as institutions has been understudied and scantily addressed in policy.

KEY WORDS: adaptive strategies, social construction of markets, livestock, climate change, land tenure, Sahel

Introduction

In the Sahelian and Sudanian areas of West Africa, such as in Mali, livestock play an important role in livelihoods and national economies (Bizimana *et al*. 2011). To cope with the high rainfall variability that affects the availability of water and pasture for animals (Yengoh 2012; Mortimore 2010), livestock producers have long applied strategies based on mobility and changes in the composition of herds (Djoudi *et al*. 2013; Adriansen 2008). Mobility consists of moving animals to areas where water and pasture are available and contributes to the sustainability of pastoral systems (Fratkin and Mearns

2003; Pedersen and Benjaminsen 2008; Fernandez-Gimenez and Le Febre 2006). However, agricultural expansion in recent decades has reduced the grazing resources available. Mobile livestock producers now face restrictions in their access to pasture resources, which have constrained their adaptive strategies to climate variations (Turner 2009; Turner and Williams 2002; Hobbs *et al*. 2008). In many areas of West Africa, producers perceive non-climatic factors (such as reduced pastoral lands or livestock disease) as more important than climatic factors in explaining decreases in income from livestock (Mertz *et al*. 2010; Tschakert 2007). The expansion of croplands has increased conflicts between pastoral herders and farmers, even though most farmers also own livestock and are at same time farmers and herders (Batterbury and Warren 2001; Moritz 2010).

In addition, decentralisation policies have exacerbated the vulnerability of livestock producers, as municipalities can restrict and tax the access and the use of communal lands by outsiders such as transhumant herders. Mali's decentralisation process was launched in 1996 but the transfer of competence in the management of natural resources to municipalities has not yet been validated in legislation (Ribot 2004; Benjamin 2008; Gautier *et al*. 2011). Despite this, many municipal authorities have created transit corridors that restrict transhumance to areas outside of croplands in order to avoid conflicts between agricultural and pastoral activities (Turner 2009). These restrictions to pasture access constrain livestock mobility and limit livestock producers' capacity to adapt to climate variability (Ickowicz *et al*. 2012).

In this context, livestock producers have diversified their livelihoods by increasing their farming activities, making items for sale, engaging in temporary paid labour locally, or migrating to seek opportunities elsewhere (Batterbury and Warren 2001; Mortimore and Adams 2001; Mertz *et al*. 2010). They have also modified herd composition, for example by destocking, restocking, lending animals to relatives and changing stock type (e.g. from cattle to small ruminants), and herd management, for example with supplementary feeding – some livestock producers have increased their use of agricultural by-products (cottonseed cakes and rice straws in Mali) from fields of their own or third parties to feed their animals (Fafchamps *et al*. 1998; Blench and Marriage 1999; Brockhaus *et al*. 2013; Turner and Williams 2002; Fernandez-Gimenez and Le Febre 2006).

However, few studies have examined the role of markets in the adaptive strategies of livestock producers in West Africa (Tessema *et al*. 2013), the changes in strategies for capturing market opportunities (Thornton *et al*. 2009) and the social interactions that lead to changes in market access and functioning. Recent livestock market evolutions have created new opportunities for livestock producers; urban demand for meat has increased quantitatively and qualitatively (Delgado *et al*. 2001) and infrastructure, banking services and mobile phone coverage have all improved (Aker and Mbiti 2010). West Africa has a long history of livestock trade (Dupire 1962; Amanor 1995; Grégoire 1997) and cities in Côte d'Ivoire have always been a natural outlet for Malian herds (Tricart 1956; Delgado and Staatz 1980). Other important markets have developed in Senegal, especially since the internal conflicts in Côte d'Ivoire in 2002 (Alary *et al*. 2007) and demand in West African cities for meat from the Sudanian and Sahelian zones is still unsatisfied (Williams *et al*. 2006). Despite the competition from cheaper meat from South America and Europe in African coastal cities (Williams *et al*. 2006), consumers prefer live animals for rituals or fresh meat rather than frozen products. In addition, road improvements (for example from Bamako to the Mali–Senegal border and toward Côte d'Ivoire) have facilitated livestock trade. However, there is a knowledge gap on how these market developments have influenced stakeholders along the supply chain (Thornton *et al*. 2007).

This paper addresses the question of how livestock producers and traders have transformed their producing and marketing strategies in response to climate variability and land access constraints. We hypothesised that the challenges faced by livestock producers have led to changes in producing and marketing strategies and the social construction of supply chains by producers and traders. We first present different conceptualisations of the role of markets in vulnerability and adaptation and propose a conceptual framework. In this, vulnerability is interpreted as a function of exposure (variations to which a system is exposed) and the sensitivity and adaptive capacity of a system (McCarthy *et al*. 2001). Multiple exposures (for example climatic variations and pasture access restrictions) can affect livestock producers (our system) and trigger responses to cope with exposures or adapt to them. We then apply the proposed framework in our case study in the region of Niono and Ségou in the Niger Inner delta in Mali and discuss the findings.

Conceptualisations of the role of markets in vulnerability and adaptation

The vulnerability of farmers is influenced by changes in product markets (e.g. demand or prices) and the access that farmers have to these markets. The chapter on rural areas in the fifth report of the IPCC (Dasgupta and Morton 2014) highlights the complex effects access to international markets can have on farmers: trade can reduce the adaptive capacity of small farmers (e.g. by reducing crop diversity) but equally, distance from large markets can also increase vulnerability by limiting livelihood opportunities. However, in South Africa and Ethiopia, access to international markets had the opposite effect (Bryan

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et al. 2009): good market access increased the adaptive capacity of farmers by providing opportunities, and poor market access meant farmers in more remote places implemented adaptive strategies because of fewer income-earning opportunities and higher aversion to risks posed by climatic variations. The different perspectives on the role of markets in vulnerability and adaptation have resulted in diverse market-related adaptation options, which can include for example facilitated access to international markets or, on the contrary, protection from them (e.g. through higher import taxes) (Barbier *et al*. 2009).

Markets in frameworks of multiple exposures

Geographical or institutional access to markets exposes farmers to market variations and shocks, particularly in a context of economic globalisation. Here markets are framed as one among multiple exposures: in this perspective, farmers are exposed to various market or climatic variations, for example global environmental change and globalisation in the framework of double exposure proposed by Leichenko and O'Brien (2008) or diseases, climate change, or trade liberalisation in another framework of multiple exposures (O'Brien *et al*. 2009). When defining multiple stressors as conditions or events that interact and provoke or require changes in livelihoods, the IPCC includes market volatility as a type of stressor (Olsson *et al*. 2014).

There are many real-world examples of market volatility interacting with other stressors. Food crises in the Sahel, for example, have often resulted from interacting climatic hazards and market shocks in addition to other driving forces such as political instability (Mertz *et al*. 2011). In Mozambique, economic stressors and shocks increased the vulnerability of small-scale agriculture to climate variability (Silva *et al*. 2010). As a result of such examples, increased market integration is often seen as a risk (Rass 2006) but can represent a stimulus that provokes a change, either positive or negative (Berrang-Ford *et al*. 2011).

Exposure to markets is regulated by the institutional and production context, which can amplify or buffer market shocks (Tucker *et al*. 2010). Geographical proximity to market places mediates the exposure to market variations and competition. For example, a vulnerability assessment of Indian farmers considered the exposure of farmers to globalisation and climate change and used the distance to the nearest international port as one vulnerability indicator (O'Brien *et al*. 2004). Different farming systems also have different sensitivities to climate variations, for example diversified livelihoods can benefit from better market access through increased income and reduced risk, but an increased dependency on a specific market can increase vulnerability (Seville *et al*. 2011).

Markets as an opportunity for coping or adapting

Another perspective on the role of markets in vulnerability and adaptation considers market access as an opportunity that helps farmers cope with – or adapt to – climate variations. Whereas market access is part of the exposure component of vulnerability in the former perspective, markets influence adaptive capacity in this one. Changes in markets create new opportunities that benefit farmers and, sometimes, farmers adopt new climate-resilient strategies because of market opportunities rather than because of climate variations (Barbier *et al*. 2009; Mertz *et al*. 2009). Opportunities are not only provided by food or animal markets (either as farm outputs, production assets, or goods consumed by households), but also by insurance and credit markets (De Jode 2010). Exclusion from markets is considered a major risk (Rass 2006) or a constraint to adaptation (Kabubo-Mariara 2009) and some coping and adapting strategies such as migration can be motivated by the prospect of better market access (Paavola 2008). This perspective leads to recommending adaptation projects and policies that facilitate market development and access (Bryan *et al*. 2009; Kabubo-Mariara 2008).

Indirect effects of markets on vulnerability: amplifications, teleconnections and self-regulation

Another way to conceptualise the role of markets on vulnerability and adaptation is through their indirect effects on vulnerability. Climate variations can affect markets, which in turn increase or decrease the vulnerability of producers. First, local and regional agricultural markets can amplify vulnerability when climate variations lead to higher prices or increased volatility and so undermine food supply (Noble and Huq 2014). This is the case for example when cereal prices increase after regional harvests are affected by a drought, making it difficult for households to buy food for consumption. Another example of local or regional amplifications is when livestock producers use their animals as buffer stocks and sell them for coping with the effects of a drought. As many farmers apply the same strategy at the same time, the cattle price generally declines dramatically, undermining the effectiveness of the strategy (Kazianga and Udry 2006). Sometimes, market failures can also lead to food supply decline in national or local markets after climate events, in which case even when people have money to buy food, there is nothing to buy (Speranza *et al*. 2010).

Second, global markets can create teleconnected vulnerability when climatic impacts in one region increase or decrease vulnerability in another region through changes in prices or demand (Eakin *et al*. 2005; Adger *et al*. 2009). The increase in food prices as a result of climate impacts in producing regions can benefit producers that are not affected by climate in

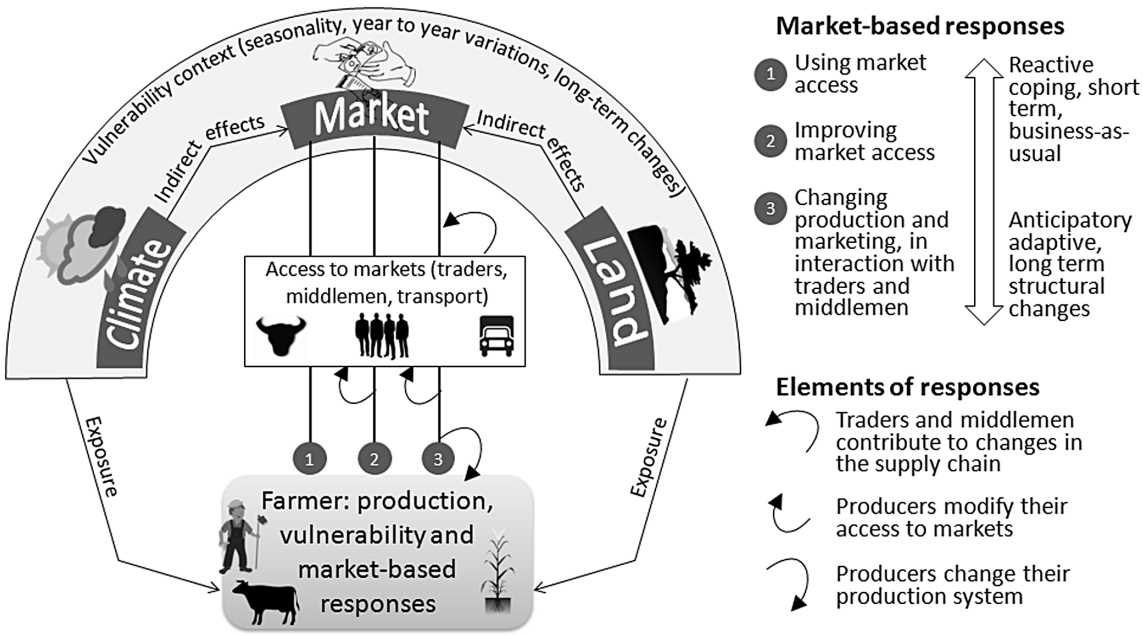

Figure 1 Conceptual framework on the role of markets in vulnerability and adaptation. Markets are a contextual factor of exposure ('Exposure' arrows), but also provide opportunities for market-based responses (arrow 1). Markets also affect vulnerability indirectly through amplifications, teleconnections and regulation of other exposures ('Indirect effects' arrows). For benefiting from more market opportunities, producers can modify their market access (arrow 2). Some more proactive strategies of producers, in interaction with middlemen and traders, include changes in production systems, access to markets and the overall supply chain (arrow 3)
Source: Authors

another region, although food security and consumer welfare may also be affected everywhere (Klein *et al*. 2014).

Third, livestock markets can buffer the impacts of climate variations through the regulation of stocking pressure. Turner and Williams (2002) described this conceptualisation of livestock markets as regulating entities, which could facilitate the movement of animals from areas affected by drought to better suited areas. As such, animal trade could reduce stocking pressure where pasture and water resources are lacking therefore reducing the vulnerability of both livestock producers and natural resources. However, the functioning of livestock markets in dry lands lower this optimism about markets regulating human–nature relationships and reducing vulnerability (Turner and Williams 2002).

A proposed conceptual framework on the role of markets in vulnerability and adaptation

Here we propose a conceptual framework encompassing the different presented perspectives on the role of markets in vulnerability and adaptation (Figure 1). In all these perspectives, markets are considered a contextual factor that drives vulnerability (directly and indirectly) through exposure and adaptive capacity. Market access and supply chains are represented as beyond the control of farmers, who can use markets for selling their products or improving their market access. In our proposed framework, we add a proactive strategy of stakeholders along the supply chain, through which market access is socially constructed. In other terms, market access is based on social networks in which linkages between actors have been built from past and present interactions (Granovetter 1973) and follows the norms and rules embedded in the complexity of these networks (Macaulay 1963; Uzzi 1997). These interactions between producers, middlemen and traders influence and transform the supply chain, for example by connecting production areas to new markets and modifying production systems to respond to the urban demand for new products. This paper will illustrate this strategy with an example of livestock systems in the Sahel, where production and marketing systems are currently evolving.

Livestock markets, vulnerability and adaptation in Mali

Case study description

In Mali, the towns of Ségou and Niono are important nodes of livestock trade between local production

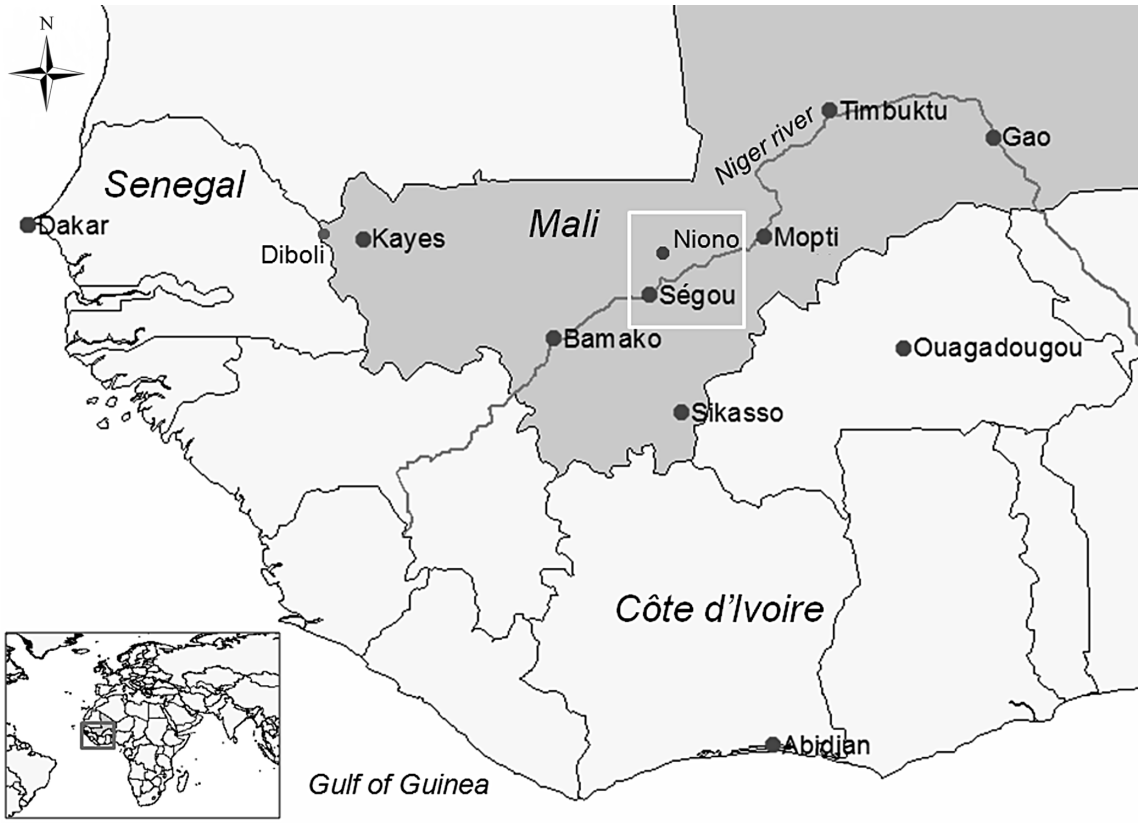

Figure 2 Location of the study region around Ségou and Niono in Mali (white box) and places mentioned in the paper (grey dots)
Source: Authors

areas and national or regional markets. They are located on livestock transhumance routes (Brottem *et al*. 2014; Gallais 1988) and close to the urban market of the capital Bamako and the irrigation schemes of the Office du Niger (Figure 2). The region is characterised by a semiarid climate with a marked rainy season from June to September. The main economic activities are agriculture (irrigated rice and vegetable cropping where irrigation is possible, or rain-fed agriculture of cereals elsewhere), livestock breeding, and fishing. We identified five zones in the study area, according to agro-ecological conditions and the most frequent farming types. Within each zone, most people have similar livelihood assets and activities, such as crop and livestock types and management (e.g. dairy farming and animal fattening). The five dominant farming types in the five zones are the following: predominantly irrigated agriculture; mixture of irrigated and rain-fed agriculture; predominantly rain-fed agriculture; agropastoralism (i.e. combination of rain-fed agriculture and pastoralism); predominantly transhumant pastoralism.

Methods

In 2008 and 2009, we interviewed 150 traders and middlemen along livestock supply chains, in the two main livestock markets in our study region (Ségou and Niono), in 12 secondary and around 30 regrouping markets that were identified as livestock sources by middlemen in Niono and Ségou, and in other markets along the western corridor of Mali, going from Niono to the Senegalese border via Kayes. The data collection was aimed at understanding the practices of traders, and indirectly producers, and mapping the flows of marketed livestock, by foot or truck, in the region. We could not start from producers to understand the flow of animals because the involvement of multiple secondary markets and intermediaries made it difficult to follow the movements of animals to the main markets. Therefore, to track livestock routes, we interviewed traders and middlemen at the main markets, and then moved from these main markets to secondary markets and regrouping markets.

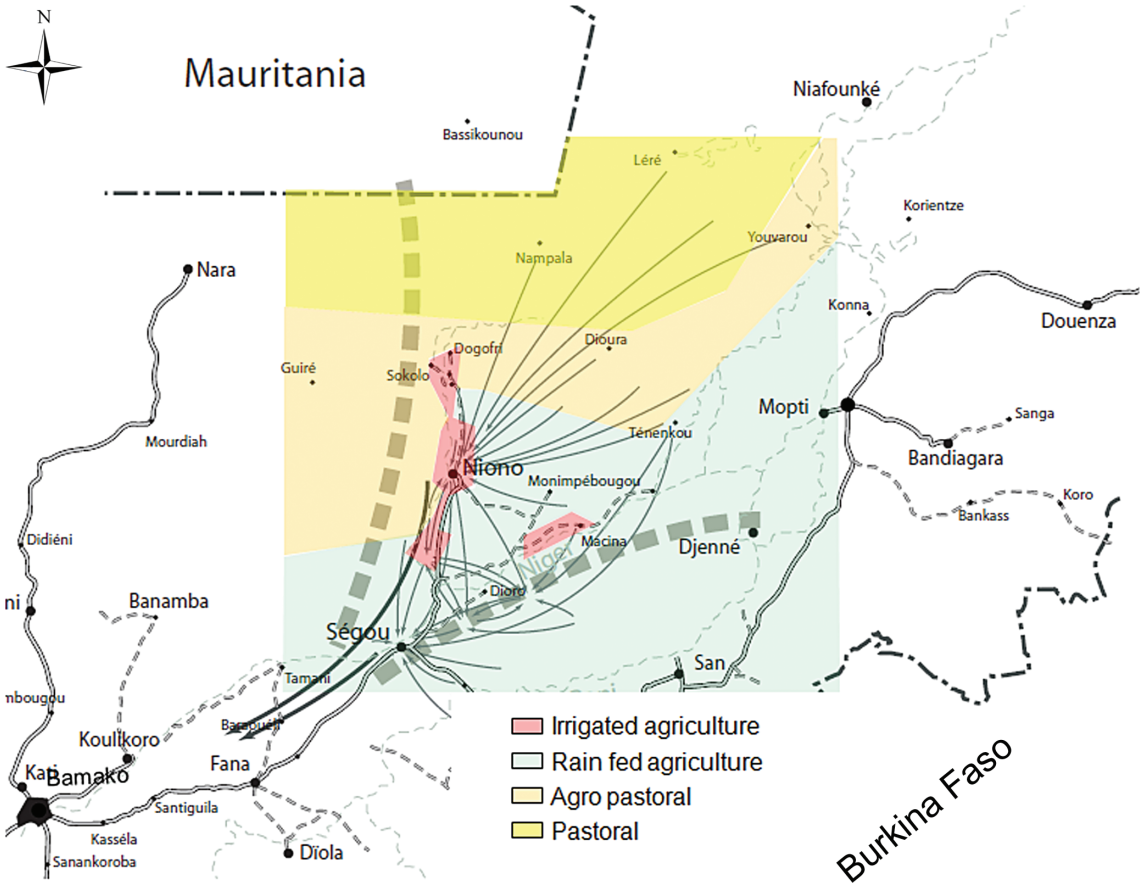

Figure 3 Flow of livestock to the markets of Niono and Ségou according to our market surveys and schematic map of production systems in the region
Source: Authors

We carried out surveys of livestock producers in the Office du Niger region to understand the importance of livestock trade to their livelihoods, their modalities and reasons for selling or buying animals, and their perceptions of the changes in market functioning and livestock production. Our aim was to understand the changing role of livestock marketing in livelihood strategies, especially in a context of new challenges faced by households. Based on consultations with resource persons, we selected two villages in each of the five farming zones and randomly chose five producers in each village. The 50 producers were interviewed about household livelihoods (including household composition, equipment, agricultural and livestock production, or off-farm activities) (Alary *et al*. 2011). Interviews also addressed market strategies and the perceived and expected changes in markets and the role of livestock in livelihoods.

Understanding the connections between livestock producers and markets through a spatial analysis

The livestock flows to Ségou and Niono markets differed and the catchments of the two markets were found to be spatially distinct (Figure 3). The livestock supplied to Ségou market came from a maximum distance of 80–100 km and had often passed through secondary markets. Most livestock reaching the large regional Niono market were linked to the seasonal livestock migration path (mostly between October and February) from the Inner Niger Delta. Some came from secondary markets but, in general, the livestock sold in Niono were involved in fewer previous exchanges than the livestock sold in Ségou.

The two livestock markets were found to be associated with different livestock production systems (Figure 3). The distinct trade opportunities offered by the two markets and the consequent livestock flows to

Table 1 Costs and benefits of livestock raising per farm in each type of farming system (from a sample of 50 farms, 10 per system)

Production system	No. of livestock (in Tropical Livestock Units, TLU)	Total benefits from livestock products (sold and self-consumed, including meat, dairy, manure, traction)	Income from the sale of livestock products (% of total benefits)	Cost of livestock production (inputs and animal purchase)	Net benefit of livestock production	Net benefit of livestock production per capita in the household
1. Irrigated	17.4	460	140 (31%)	430	31	2.2
2. Rain-fed and irrigated	9.3	380	54 (14%)	120	260	21
3. Rain-fed	6.7	370	14 (4%)	27	340	13
4. Agropastoral	4.9	140	35 (26%)	18	120	16
5. Pastoral	32.2	1000	150 (15%)	87	880	59

All costs and benefits are in thousand XOF/year/farm (for reference, the poverty line in 2006 was 144 000 XOF/year/capita).
Source: Authors

them depended on the match between market styles and livestock production systems. Our surveys confirmed that Niono market was mostly attended by transhumant herders coming from the grazing areas along the northwest bank of the Niger River, whereas Ségou was a major market for farmers (irrigation, rain-fed or mixed irrigation and rain-fed) and agro-pastoralists living in the wide periphery of the city and irrigated areas.

Pastoralist and irrigation farmers differed from the three other types of livestock producers. Our surveys showed that they had larger cattle herds and sold more animals than other producers (Table 1). Irrigation farmers, generally well-off, raised animals to diversify their activities but livestock production was less important for their livelihoods compared with other producers, except for working oxen. They fattened some of the animals at the farm (with supplements and agricultural by-products) and entrusted others to shepherds, who had to deal with the shrinkage in pasture area. Livestock sales formed an important safety net for most households of all categories: when they did not have any money for unexpected health expenses, 67% of the households sold animals. Around 58% of households had recently faced money shortages for buying food (80% of pastoralists and 50% of others) and all of them sold animals for this purpose.

The net benefits of livestock raising for irrigation farmers were small, particularly because of the cost of shepherds (around 40% of the expenses) and animal feed. In comparison, pastoralists had larger benefits and lower costs because animals were not fattened and grazed along transhumance routes. Livestock net benefits were less important in the three other production systems, but were not negligible. Pastoralist and irrigation farmers were the most connected to markets, albeit to different markets: more to Niono for pastoralists and to Ségou for irrigation farmers. Irrigation farmers received higher prices per head in Ségou for a quality premium, as they had invested in the fattening of animals.

Recent evolution of the strategies of market traders

Livestock traders have developed new strategies for proactively seeking out deals according to many interviewed farmers and traders. Major changes in meat demand from markets have been confirmed by our interviews, with a growing demand for better quality meat in the region, especially in the large cities and at particular dates. Some interviewees reported that these changes led them to develop more and more elaborated strategies. Proactive traders, generally well-off and urban (but often former herders), used their networks in the final destination, such as Bamako (Mali), Dakar (Senegal), or Abidjan (Côte d'Ivoire), to ensure that a deal was concluded with a buyer abroad before purchasing quality animals (e.g. good-looking fattened cattle, rarer and with greater added value). They gathered enough animals to be sent by truck from the nearest livestock loading dock, the number of which has dramatically increased in the region during the 2000s. Following buyers' requests, they often sought out particular animals wherever they were located: at secondary markets, regrouping markets, or even at farms. The interviewees perceived that the development of this kind of extensive search was a major change and explained it by evolutions in markets and production systems in the region in relation to climate variability and pasture access restriction. This change also occurred at both Ségou and Niono markets: in Niono, where livestock came traditionally from trans-humance routes with a highly seasonal variability, traders in this market were increasingly seeking sedentary fattened livestock throughout the year.

The so-called 'proactive' traders explained that they received requests for specific deals from urban markets by mobile phone, looked for sellers, concluded deals, gathered purchased animals, and arranged transportation. One key challenge for traders was arranging livestock transportation, either by foot, by truck or both, generally within 24 h after the deal was concluded, from the point of embarkation to the location of the final sale. The type of transportation, starting points, and stopovers (for animals to rest and drink) that they chose depended on the type of animal and their condition. One example route to Dakar was by foot from Niono to the Senegalese border (crossing at the Diboli border post but sometimes further upstream the Senegal river to avoid border taxes), then by truck to Dakar. Another was from Ségou to Diboli by truck, a stopover of 24–72 h at the border (depending on the condition of the animals and the agreement made with buyers in Dakar), and then to Dakar by truck. To be able to react quickly to proposed deals from Senegal, some traders collected animals before receiving an order and stationed them in the Kayes region, closer to the Senegalese border than Ségou or Niono. However, not all quality animals ended up in Dakar, as markets in Mali, Côte d'Ivoire, or even Ghana and Nigeria were also ordering such animals. Hence, in addition to having enough available cash, the art of the livestock trade involved knowing how to locate and select animals at markets or directly at farms (a new and increasing practice, according to our informants), plan transportation by foot or truck, and ensure the animals' health during the journey.

With the process of decentralisation and the organisation of livestock producers into cooperatives, the number of places where livestock can be loaded onto trucks dramatically increased in recent years, facilitating transportation. Other facilitating factors for livestock trade were extensions to the road network and the growth in the number of bank offices around the country, as these enabled quick deals and avoided the risk of being robbed by highway gangs. As a result of this improvement in collective assets (roads, livestock loading ramps, mobile phone networks, bank offices), the traders' own financial and social assets accounted for the differences in their efficiency. The swiftness of a trader's response to a proposed deal determined his efficiency, as several traders could compete for the same deal and delays could abort it. After having received an order via his mobile phone, a trader's key skill was to find animals of the right quality for the urban markets on the coast, with the prospect of generating higher net benefits despite higher transportation costs than for Malian urban markets. Another skill was the ability to locate a transporter rapidly. The success of all these activities relied on the use of extensive social networks and interactions with the supply and demand sides, as well as with the transportation sector.

Recent evolution of the strategies of producers, but not all

In this context of changing policies, land tenure, and markets, some livestock producers have modified their strategies to harness opportunities and reduce their vulnerability. Most producers of all types (89% on average) had perceived recent changes in livestock markets, particularly an increase in animal prices caused by a willingness to pay high prices among buyers in coastal cities. However, they had also noticed increases in feed prices and shepherd fees, which made decisions about production practices more difficult to make. Interviewees also reported that their marketing strategies along the supply chains were becoming more and more elaborate and anticipatory.

Different types of producers reacted to these changes differently: 50% of the irrigation farmers and pastoralists reported having modified their marketing strategies, whereas only 12% of the other types did. Changes included more fattening in order to sell animals at higher prices (reported mainly by irrigation farmers) or, conversely, reducing the time between buying and selling to reduce husbandry costs (reported mainly by pastoralists). Among the pastoralists, 28% reported having started to market dairy products to cover the costs of improved animal feed. Around 28% of the interviewees thought that, if current market trends continued in the long term, they would change their practices: they would invest in feeding systems and sell fewer animals of better quality at a higher price.

Discussion

In the study region, market evolution and changes in trader strategies seem to have incentivised producers to move from reactive strategies for coping with exposure (climate variability and land access restrictions) to adaptive strategies over the longer term. This move is characterised by greater anticipation and systemic changes; for example, animal feeding has increased the integration of agriculture and livestock in production systems. Most strategies currently used by producers are not new (e.g. stall feeding) but their increasing application in order to seize market opportunities is new and may indicate the beginning of a transition in livestock production and markets. The proactive behaviour of new-style traders has transformed market systems. Their shift toward greater direct contact with both middlemen and sometimes producers in our study region and buyers in neighbouring countries is in contrast to the partitioning of West African markets into domestic and cross-border segments that has previously been observed (Williams *et al*. 2006).

The transformation of marketing systems has resulted from interactions between stakeholders at

different levels, such as buyers in regional urban centres, regional traders, local middlemen, and livestock producers. Livestock producers' adapting strategies rely on the strategies of other market stakeholders and vice versa. Markets, understood as institutions with mechanisms governing the behaviour of individuals along the supply chain, result from a social construction, which has contributed to a reduction in the vulnerability of producers to land access constraints and climate variations. Indeed, these institutions mediate three broad, commonly mentioned strategies for reducing vulnerability: livelihood diversification, mobility, and wealth stores (technology being the fourth one) (Reardon *et al*. 1988; Turner 2000). However, these same institutions may also increase the vulnerability of producers, for example when producers have no alternative other than selling to traders who control prices (Reid and Vogel 2006).

Improvements in collective and public assets have facilitated this evolution of production and marketing strategies; examples are improvements in marketplaces (with infrastructure for loading animals onto trucks), mobile phone networks, bank offices, and roads, as shown by other studies (Bizimana *et al*. 2011; Corniaux *et al*. 2012). Some traders succeed in responding to the demand from regional urban markets thanks to these collective assets, which are of benefit to livestock producers too. However, livestock producers also need individual or household assets to capture market opportunities: physical (e.g. mobile phone), social (e.g. social networks, access to information), natural (e.g. access to pasture for animal grazing and to agricultural products for stall feeding), and financial (e.g. for supplement feeding).

The need for these assets raises the question of who can afford this transition and benefit from it, within households or among them. For example, in almost half of the surveyed households, women own livestock and 90% of them decide on their own when to sell animals, even though their husbands or sons are involved in these transactions for cultural reasons. Results showed that irrigation farmers and pastoralists differ from the other types of producers in their greater ability to benefit from – and contribute to – market evolutions. Even though all types of producers develop marketing strategies for getting the best deal and choosing between marketplaces and traders, wealthier households seem more likely to catch emerging opportunities; this has also been observed in other places, such as in the Limpopo Basin in Mozambique, where transitioning to more commercial farming is a challenge for smallholder farmers (Silva *et al*. 2010). In our study region, livestock fattening needs food supplements, which the poorest livestock producers cannot afford. This is especially so during the current cotton crisis started in the early 2000s, which has led to a reduction in the availability of seed cakes, and when Senegalese merchants buy seed cakes at high prices because they have a higher purchasing power. Even though their opportunities for mobility are shrinking, some livestock producers continue to rely on the reduced areas available for grazing in combination with common grazing on fields and supplementary feeding. The evolution of markets and pasture access may thus shift vulnerability among groups and change power relationships and wealth redistribution effects (Turner and Williams 2002; Ickowicz *et al*. 2012), to the detriment of the least well-off and least powerful, who are also those who have less influence on collective decisions about land access (Lebert and Rohde 2007).

Further research is needed on the dynamics of animal production and trade in the Sahel to confirm whether a transition is underway or whether the observed trends are temporary (Fernandez-Gimenez and Le Febre 2006). Research could also aim at elucidating how the evolution of markets and pasture access shifts vulnerability within households; for example, research could explore how the gender-differentiated strategies and access of men and women to markets benefit households and reduce vulnerability of household members to climate and land access constraints (Turner and Williams 2002).The changes in differentiated vulnerability and power relationships among households or along supply chains are also relevant, for example how traders and middlemen benefit from the changes and who among them loses or wins (Puskur *et al*. 2011).

The findings have several implications for development policies. To satisfy the growing demand for meat, there is a need to improve production and access to animal supplementary feeding and to preserve at the same time grazing areas and corridors for pastoralists. Policies could also support the development of information dissemination (on prices and quality demand), marketing skills, and producer associations (Tessema *et al*. 2013). Despite improvements in infrastructure, much remains to be done to facilitate the functioning of marketplaces and transportation. As institutional barriers to livestock trade can have negative impacts on a large population of producers (Williams *et al*. 2006), regional policy reforms can be used to remove policy and non-policy barriers to regional trade, such as high official and non-official taxes or road blocks (Williams *et al*. 2006; Corniaux *et al*. 2012). The current regional political process of consolidating economic integration within the Economic Community of West African States may present new opportunities.

Conclusion

Using field data collected along livestock supply chains in the Office du Niger region, Mali, this study identified new production and marketing strategies developed by livestock producers, in interaction with traders, to reduce their vulnerability to climate

variability and land access constraints. The current evolutions of regional meat demand and the changes in collective communication and transportation infrastructure may have led to the beginning of transition in commercial practices and in livestock production systems in Mali, towards more reactivity to the demand from urban markets and more stall-fed production. This study highlights the importance of considering the social construction of livestock market systems and marketing behaviours as adaptive strategies of livestock producers to multiple changes. It also emphasises the need to analyse this transition in more detail to understand the winners and losers in the recent market evolution. Although livestock markets can support the adaptive strategies of several types of producers, their functioning as institutions has been understudied and scantily addressed in policy.

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